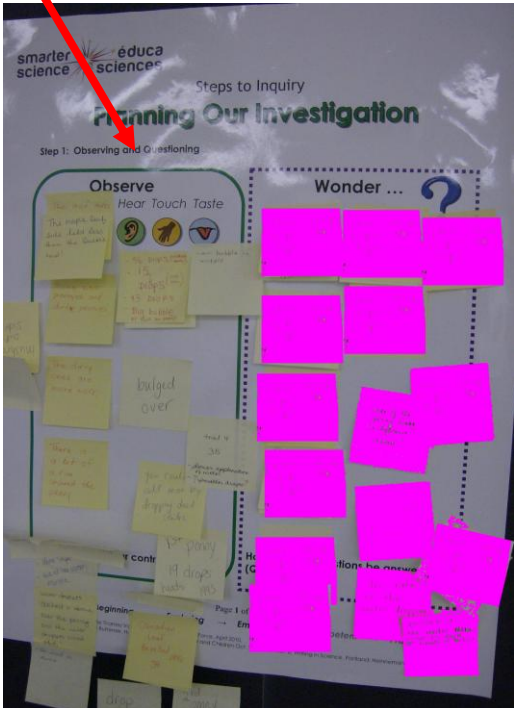


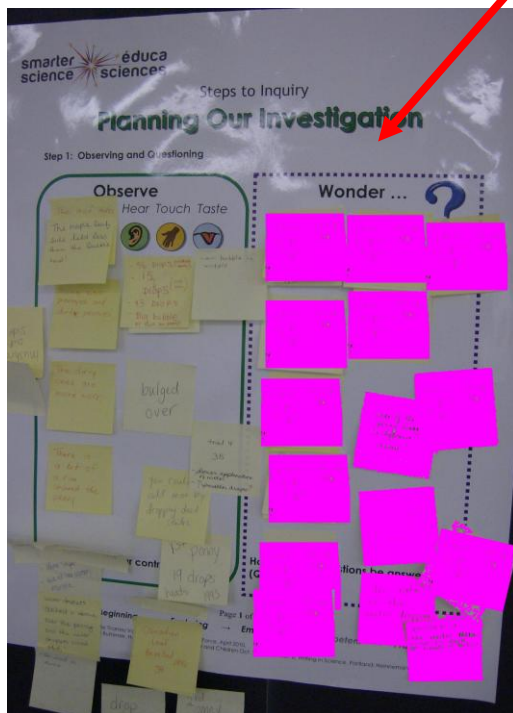
Steps to Inquiry: Initiate and Plan

Adapted from: Rees, Carol. "Smarter Science: A visit from Jennifer Parker, Rick Pardo and Mike Newnham." *Crucible Online*. June 2010.
and <http://smarterscience.youthscience.ca>

Step 1: Observing & Questioning	Examples
<p><i>*Prior to starting class, have materials available for students to observe and/or perform an experiment.</i> <i>*Consider grouping students in pairs or small groups.</i></p> <p>→ Performing/Observing an Experiment</p> <ul style="list-style-type: none"> Students perform and/or observe an experiment/demo Each student records their observations (using their senses) on a yellow sticky note in words or pictures Help students deepen observations through prompting questions One student from each group posts the sticky notes under the "Observe" or "What did I Observe?" box from Step 1 of the <i>Steps to Inquiry</i> posters 	<p>Performing and Observing Example Experiment Students: observe the physical properties of 5 mL samples of $\text{HCl}_{(aq)}$, $\text{NaOH}_{(aq)}$, and phenolphthalein (they are all clear)</p> <p>add two drops of the phenolphthalein to the NaOH and HCl (NaOH turns pink, HCl stays clear)</p> <p>mix the NaOH with the HCl (should be clear)</p> <p>pour solution into evaporating dish; heat the solution until it evaporates (white solid – NaCl)</p> <p>Example Observations: HCl and NaOH are clear liquids Phenolphthalein is a clear liquid with pungent odour Phenolphthalein turns pink in NaOH Phenolphthalein stays clear in HCl White solid is formed after heating</p>

→ Questioning based on Observations

- Students think of questions they have about what they observed
- Students write each question on a pink sticky note (or a sticky note that is different in colour from the observations sticky notes)
- One student from each group posts the sticky notes under the “Wonder...?” or “What am I Wondering?” box from Step 1 of the *Steps to Inquiry* posters



- Sort the questions into three types:
 - questions that can be answered by research
 - questions that can be answered by investigation with research
 - questions that are speculative and cannot be easily answered by investigation or research
- Explain to students that questions answered by investigation with research can lead to “Testable Questions” which is the focus of scientific inquiry

Sample Questions

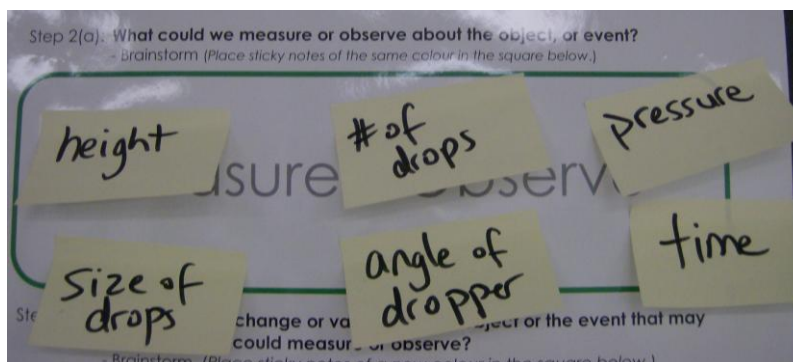
“I wonder what would happen if I used more NaOH?”

“I wonder what would happen if I used a different acid or base?”

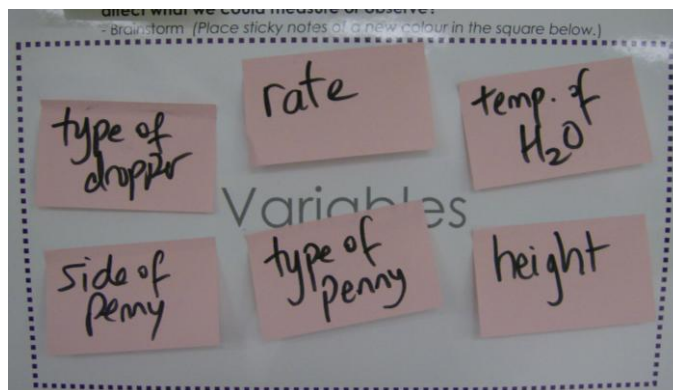
“How can I produce more of the white solid?”

Step 2: Identifying the Variables, part 1

- The observations from Step 1 become possible things that can be measured or observed in Step 2(a).
- Sticky notes are moved from the “Observe” or “What did I Observe?” green box of Step 1 to the green box in Step 2(a). These sticky notes may be reworded in terms of measurability for Step 2(a).



- Sticky notes posted in the purple “Wonder...?” or “What am I Wondering?” box in Step 1 (and determined as testable in the question sort) are moved to the purple box in Step 2(b). These may also need to be reworded.



Sample Dependent Variables

mass of solid
volume of NaOH
temp. of solution
colour

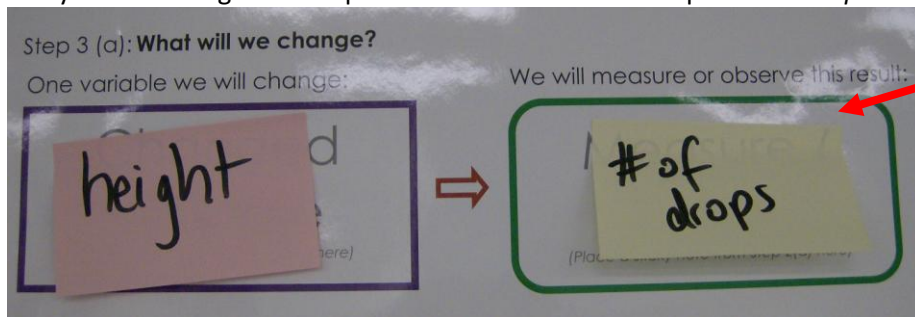
Sample Variables

add more/less NaOH
add more/less HCl
use warm solutions
add more/less drops of phenolphthalein
use different acids

Step 3: Identifying the Variables, part 2

→ Choosing a Dependent Variable

- Students decide on one “Dependent Variable” from Step 2(a) that they would like to measure/observe in order to inquire about their independent variable
- Move this sticky note to the green “Dependent Variable” box in Step 3 of the *Steps to Inquiry* posters



Sample Sentence

One variable I will change is the volume of HCl and I will measure the mass of solid formed.

Sample Controlled Variables

amount of NaOH and phenolphthalein
temperature
use the same acid

Sample Sentence

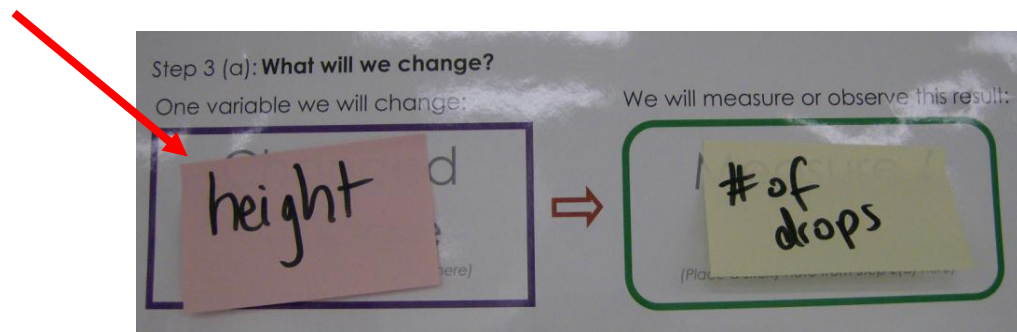
One variable I will change is the type of acid used and I will observe the colour of the final solution.

Sample Controlled Variables

amount of acid, NaOH and phenolphthalein
temperature

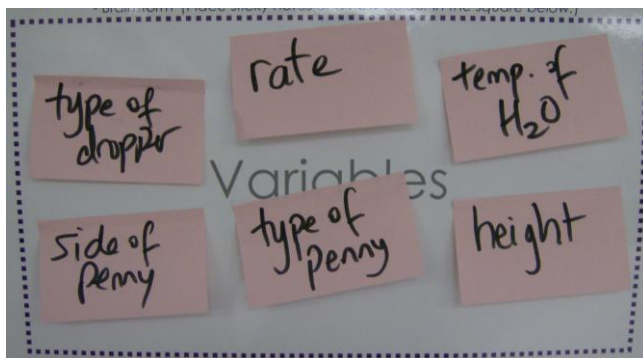
→ Choosing an Independent Variable

- Students decide on one variable from Step 2(b) that they would like to change for their experiment
- Move this pink sticky note to the purple “Independent Variable” box in Step 3 of the *Steps to Inquiry* posters
- Students now have two sentences completed: *One variable we will change is...* and *we will measure or observe...*



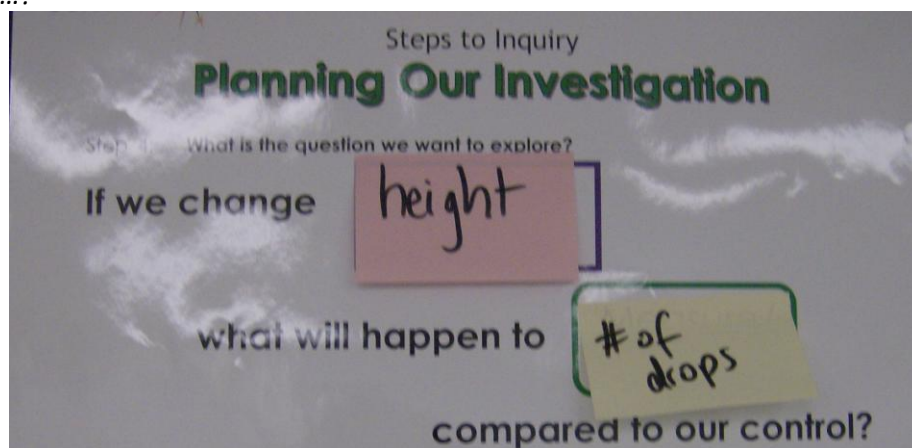
→ Identifying Controlled Variables

- Move the remaining pink sticky notes from Step 2(b) to the purple “Variables” or “Control Variable” boxes in Step 3 of the *Steps to Inquiry* posters
- Explain to students that they have identified all of the variables that must be controlled in their experiment



Step 4: Generating a Testable Question

- Move the pink “Independent Variable” sticky note and the yellow “Dependent Variable” sticky note from Step 3 to Step 4 of the *Steps to Inquiry* posters to generate a testable question: *If we change...what will happen to...?*



Sample Question

If we change the volume of HCL what will happen to the mass of the solid formed compared to our control?

Step 5: Writing a Prediction

- Students use the prompts in Step 5 of the *Steps to Inquiry* posters to write a prediction (what and why)

Step 5: What is my prediction (what and why)?

Based upon height I predict that:

if the height increases (↑ or ↓) _____

How will the independent variable be changed?

What? then the # of drops will increase (↑ or ↓) _____

How will the dependent variable be affected?

I think this will happen because _____

Why? _____

Sample Hypothesis


If I change the volume of HCl then I predict this will happen to what I will measure or observe: the mass of the solid will increase. I think this will happen because increasing the volume added to the reaction will increase the amount of solid formed.


See Appendix for "Steps to Inquiry" c/o <http://smarterscience.youthscience.ca/resources> where you can download these posters/handouts. "Steps to Inquiry" can be used in any science class, Grades 1-12.

Some notes for the example/pics:

- This example can be used for SNC2P/2D (Overall A1, C2; Specific A1.1, A1.2, A1.4, A1.5, A1.6, A1.8, A1.10, A1.11, A1.12, C2.5). All the specific expectations listed can be met if the entire "Steps to Inquiry" framework is completed. For the complete framework, visit <http://smarterscience.youthscience.ca/resources>.
- Materials needed for initial experiment (per group): 5 mL of 0.1 M HCl_(aq), 5 mL of 0.1 M NaOH_(aq), 5 mL of phenolphthalein, 1 dropper, 3 test tubes, evaporating dish, hot plate
- Safety: HCl and NaOH are corrosive. Students must have goggles on. The evaporating dish gets extremely hot so make sure it is completely cooled before it is handled by students.
- Pictures were taken from an experiment at a teacher in-service whereby participants are experimenting with water, a penny, and a disposable pipette and trying to answer the question "How many drops of water fit on a penny?" They made observations and then starting generating questions to develop their own inquiries. E.g., If we change the height of the dropper, what will happen to the number of drops that can fit on the penny compared to our control?

Appendix: Steps to Inquiry – Initiate and Plan





Steps to Inquiry Initiate & Plan

Step 1: Observing & Questioning

What did I observe?
(What do you notice about the object or event? Use your senses to describe the object or event.)

This is the control.

What am I wondering?
(What questions or predictions do you have about the object or event?)


How can the questions be answered?
(Question Sort)


Labelled diagram:

Page 1 of 4

Process Skills: *Beginning* → *Exploring* → *Emerging* → *Competent* → *Proficient*

Modified & Revised by the Thames Valley D.S.B. Elementary S&T Task Force, April 2010.
Originally adapted from: Buttemer, H. "Inquiry on Board." Science and Children Oct. 2006; Fulwiler, B. Writing in Science. Portland: Heinemann, 2007.





Steps to Inquiry Initiate & Plan

Step 2(a): What could I measure or observe about the object, or event?
- Brainstorm *(Place sticky notes of the same colour in the square below.)*

Possible Dependent Variables

Step 2(b): What could I change or vary about the object or the event that may affect what I could measure or observe?
- Brainstorm *(Place sticky notes of a new colour in the square below.)*

Variables

Page 2 of 4

Process Skills: *Beginning* → *Exploring* → *Emerging* → *Competent* → *Proficient*

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Steps to Inquiry Initiate & Plan

Step 3 (a): What will I change?

One variable I will change:

Independent Variable
(Place a sticky note from Step 2(b) here)



I will measure or observe this result:

Dependent Variable
(Place a sticky note from Step 2(a) here)

Step 3 (b): What will I not change?

Variables I will NOT change:

What conditions will be held constant so it is a fair test? Place remaining sticky notes from Step 2(b) here.

Control Variable	Control Variable	Control Variable
Control Variable	Control Variable	Control Variable

Page 3 of 4

Process Skills: Beginning → Exploring → Emerging → Competent → Proficient

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Steps to Inquiry Initiate & Plan

Step 4: What is the question I want to explore?

If I change

Independent Variable

what will happen to

Dependent Variable

compared to the control?

Step 5: What is my prediction (what and why)?

Based upon my question, I predict that :

if the _____ is (↑ or ↓) _____
Independent Variable How will the independent variable be changed?

What?

then the _____ will (↑ or ↓) _____
Dependent Variable

How will the dependent variable be affected?

I think this will happen because _____

Why?

Page 4 of 4

Process Skills: Beginning → Exploring → Emerging → Competent → Proficient

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